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(54) Sail for sailing craft and method for making same.

(57) A single panel sail is made by stretch forming a thermoplastic film or laminate of film and fibers against a shaped caul or mold, preferably with the use of heat and pressure, such that the film is permanently deformed into a three dimensioned shape having the desired profile or fullness required in the sail under actual sailing conditions.

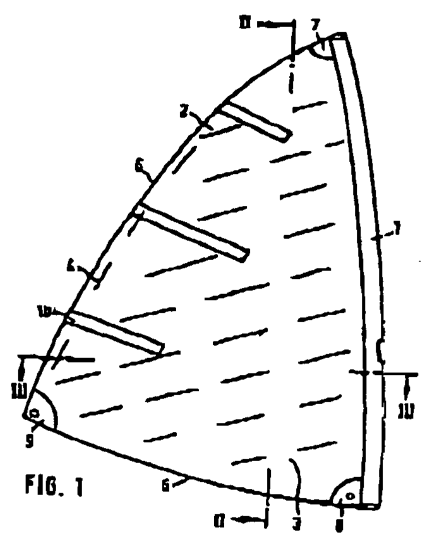

FIG. 1

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Sail for sailing craft and method for making same

Traditional methods for manufacturing sails include selection of the proper woven fabric or cloth, precisely cutting the cloth into a plurality of flat panels, and then sewing adjacent panels together along overlapping edges. Modern sails are typically made from special, closely united synthetic yarns, and the cutting and sewing procedure is time consuming and expensive. The finished sails are normally cut to provide a slight curve along the luff und the foot. When the sail is installed in the rigging, the luff leach and foot may be placed unter tension, causing the sail to have fullness or a three dimensional curved shape necessary to give it thrust under sailing conditions.

Various attempts have been made to manufacture a sail either with a pre-formed draft or fullness, or from continuous pieces of material. Due to the limited class of commercial materials suitable for making sails, which must be flexible and yet stretch resistant, and the lack of a suitable method useful for light weight materials, these proposals have been largely unsuccessful.

U.S. Patent no. 2,565,219 describes the manufacture of a sail wherein panels of cloth are placed on the surface of a curved form, and the panels are then coated with a liquid bonding material. This method does not avoid the use of precisely cut panels or the problem of obtaining a uniform coating of bonding material that also bonds firmly to the panels. U.S. Patent no. 3,903,826 illustrates a single panel sail , which is, however, unidimensional and form d by a bonding process.

The present invention provides a sail and a method for making a sail from principally a single panel of material, thereby avoiding the necessity of cutting and joining a number of separate panels. The sail material employed is a continuous, non-porous thermoplastic or thermoformable film that is preferably reinforced by thermoplastic fibers. The material is supported around its edges and then permanently formed into a three dimensional shape by elongation of a central portion thereof, preferably with the use of heat and/or pressure. Battens, attachment points and the like may be incorporated into the sail either before, during or after the forming operation.

The method of the present invention offers several advantages, including the ability to efficiently produce a large number of high quality sails very easily and quickly, and without the need for time consuming cutting and sewing operations. The material or combination or materials can be selected from those that will retain the permanent three dimensional shape while imparting superior properties. Also, suitable sail materials having desirable properties such as stretch resistance, flexibility, smoothness, tear resistance, and the like may be incorporated into a pre-formed sail, thereby greatly increasing the sailing performance and useful life of the sail.

In accordance with the present invention, a sail for sailing craft or other wind propelsion devices, as generally shown in Figures 1-3, is prepared principally from a single piece or sheet of material, although it will be appreciated that, less desirably, a plurality of pieces of such material could be used and joined together either before, during or after the forming

operation described herein. The sail as shown in the drawings is generally triangular in shape and comprises a head 7, a tack 8 and clew 9 at the three corners. The leading portion or luff of the sail is typically joined to a rope or tubular portion 1 that fits around a mast. Although the sail as illustrated is particularly suitable for so-called surfboard rigs, it will be appreciated that other types of sails can be made by the process of the present invention. Also, the principles of the present invention are applicable to any type of sail regardless of how it may be rigged.

The materials used to construct the sail are composed of thermoplastic materials that can be stretch formed or thermoformed without appreciable loss of stretch resistance and other mechanical properties required in a sail. For example, the use of woven cloth made of thermoplastic yarns, as the sole material, is not practical because the stretch forming process of the present invention would tend to unduly loosen the weave of the cloth, rendering it too porous and weak. The material must also be resistant to tear and degradation under normal use.

The preferred material comprises or includes a continuous, nonporous film of thermoplastic material which is used alone or is laminated or bonded to a second sheet of material or reinforcing fibrous materials, or both. In the case of laminates, any deficiencies in physical properties of one of the materials can be corrected by selecting desirable properties in the other materials. For example, a film having good forming properties and smoothness such as polyolefin film may be combined with fibers or films having high stretch or tear resistance.

The films employed may be composed of suitable thermoplastic polymers such as polyesters, polyamide, polyolefins or the like, or combinations of the foregoing. The fiberous materials may include thermoplastic woven or unwoven (mesh, spunbonded or the like) fibers or yarns, which are laminated, bonded or otherwise incorporated into the film. Since the fibers are normally used to impart strength and stretch resistance to the film, the fibers preferably are composed of materials such as polyesters or those polyamids or other thermoplastic polymers that have high stretch resistance while retaining flexibility. For example, a polyamid, polyolefin or polyester film 2 may be laminated on one or both sides with fiber reinforcement, such as with yarns made of polyesters. The yarns, shown in Figure 1 at 3 and 4, may be employed in an intersecting or non-intersecting pattern. To facilitate construction, the fibers may be uniformly distributed, or in the alternative, may be oriented to selectively reinforce certain portions of the sail, such as the yarns 4 extending essentially parallel along the leach 6 or the foot 5 of the sail, or concentrated at the corner 7, 8 and 9.

The composite sheet is formed into a three dimensional shape of desired configuration by the use of a stretch forming technique. Many such techniques are conventional and include the steps of first streching or supporting the sheet under tension at opposite edges, which prevents wrinkles or creases in the final product. The sheet is then permanently deformed into the three dimensional shape shown in Figures 2 and 3, either by stretching the sheet over a curved caul or form, or preferably with the use of external heating and the application of pressure against the sheet. The formed

sheet is then cooled to render it shape-retaining.

In order to make a sail having the desired degree of draft or shape, the material is elongated in the order of from about one to about 15 percent per unit length. Heat is preferably applied to render the deformation permanent and prevent shrinkage if the sail is later exposed to warm conditions such as sunlight. Also, in order to achieve the precise shape, pressure is applied to the sheet either by using a molding caul or mold, air pressure, or vacuum. The heat may be applied from a radient source or by bringing the sheet into contact with a heated object.

The temperatures employed to heat the sheet are preferably above normally encountered ambient temperatures and below temperatures that would cause the sheet or any component thereof to degrade, melt or lose other desired physical properties such as stretch resistance. In the specific case of the materials described herein, a temperature range of from about 50 to about 200 degrees C will be sufficient to facilitate permanent stretch forming. The amount of pressure employed is not critical, although higher pressures generally allow for the use of lower temperatures. The amount of dwell time for the forming process is likewise not critical, as long as the material will be permanently deformed after cooling.

Many methods are available for stretch forming the sheet. The material may be supported and inflated using air pressure alone or with the assistance of a flexible supporting membrane. The material may be supported, heated, and pulled over a mold and allowed to cool, or the mold may be separately heated and cooled. The

material may be stretch d by using air pressure either alone or in combination with a mold surface. In all cases, however, it is normally desirable to support the edges of the sheet while it is being heated and formed to provide a smooth surface on the resulting formed sheet.

The forming operation causes the thermoplastic sheet material and thermoplastic fibers to be permanently elongated, principally behind the luff or in the cenral portion of the sail. The degree and location of the shaping can be controlled, for example, by using a mold surface that has the shape desired in the final product. After the sheet has been cooled, the free edges may be trimmed.

Other structural elements, such as reinforcing for the corners, battens 10, mast attachment sleeve 1, and the like, may be incorporated either before, during of after formation of the sail by known laminating or bonding operations.

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Claims:

1. A sail for sailing craft having a three dimensional curvature for generating the forward drive for the sailing craft, characterized in that a principal portion of the sail comprising a continuous sheet of flexible thermoplastic material, said material being permanently deformed in the three dimensional curvature corresponding to the desired curvature under sailing conditions.

2. The sail according to Claim 1, wherein said material is permanently deformed by stretch forming.

3. The sail according to Claim 1 and 2, wherein said sheet is a reinforced or unreinforced thermoplastic foil or film.

4. The sail according to Claim 1 and 3 wherein said sheet material is reinforced by thermoplastic fiberous materials.

5. The sail according to Claim 4, wherein said fiberous materials are in the form of yarns.

6. The sail according to Claim 4, wherein said fiberous materials are in the form of a mesh.

7. The sail according to Claim 5, wherein said yarns are provided in an intersecting pattern.

8. The sail according to Claim 7, wherein said yarns are woven.

9. The sail of Claim 1, wherein said flexible thermo-

plastic material is selected from the group consisting of polyesters, polyamids and polyolefins.

10. The sail of Claim 1, wherein said continuous sheet comprises a plurality of layers of thermoplastic material bonded together.

11. A method for making a sail comprising the steps of supporting a continuous sheet of thermoplastic material around its edges heating the sheet to a temperature below its melting point, applying pressure to the heated sheet to selectively elongate the sheet into the form of a sail and cooling the sheet to form a curved portion therein.

12. The method of Claim 10, wherein the sheet is elongated from about one to about 15 percent per unit length.

13. The method of Claim 10, wherein the sheet is heated to a temperature of from about 50 to about 200 degrees C.

14. The method of Claim 10, wherein the sheet is reinforced with thermoplastic polymer fibers.

15. The method of Claim 14, wherein said sheet and fibers are selected from a class of thermoplastic polymers consisting of polyesters, polyamids, polyolefins and combinations thereof.

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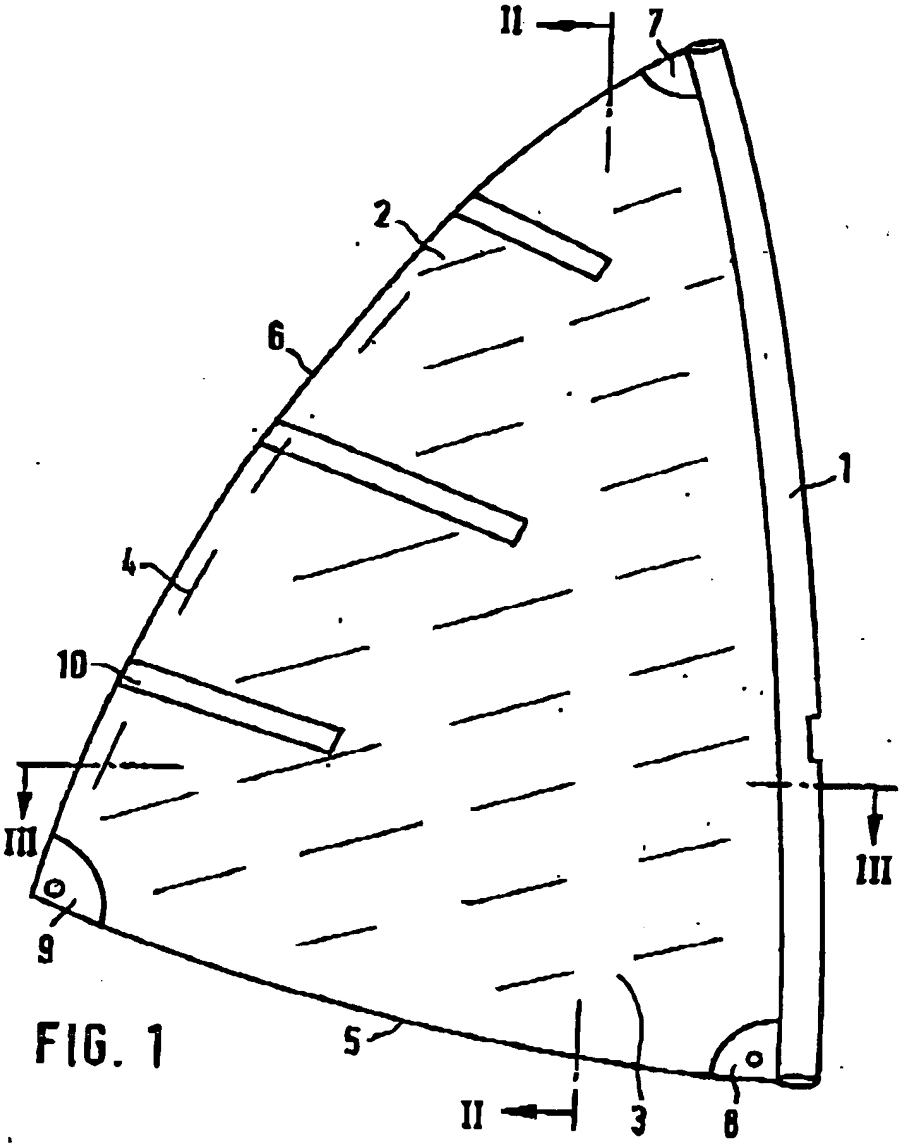

FIG. 1

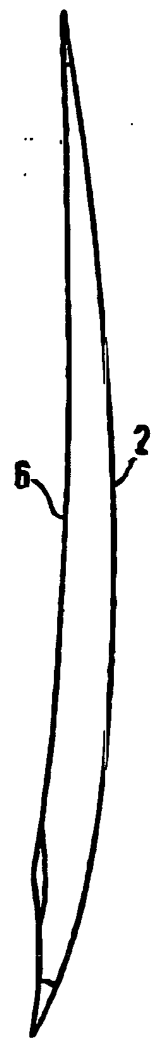

FIG. 2

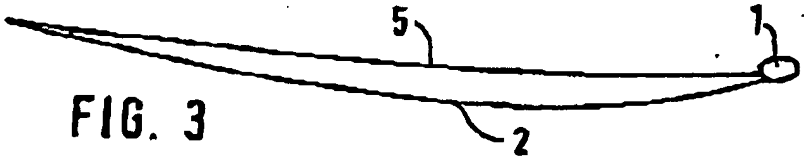

FIG. 3